

WE CLAIM:

1. An IED comprising:

a base module, said base module including:

a power monitoring circuit operative to monitor a parameter of a portion of a power distribution system and generate an analog signal representative thereof;

a processor coupled with said power monitoring circuit, said processor comprising an analog to digital converter operative to convert said analog signal to a digital signal representative thereof, said processor operative to implement first power management functionality and generate first power management data;

at least one of a display and a communications interface coupled with said processor and operative to communicate said first power management data external to said IED;

a first interface coupled with said processor and said communications interface, said first interface operative to receive a first external function module, said first external function module comprising second power management functionality, wherein said first interface is further operative to facilitate implementation of said second power management functionality.

2. The IED of Claim 1, wherein said first power management functionality comprises a first plurality of power management functions, said first interface being further operative to facilitate said second power management functionality to disable a first subset of said first plurality of power management functions.

3. The IED of Claim 2, wherein said second power management functionality comprises a second plurality of power management functions, said first interface operative to facilitate substitution of said second subset for said first subset.

4. The IED of Claim 1, wherein said first power management functionality comprises a plurality of power management functions, said first interface being further operative to facilitate said second power management functionality to utilize a subset of said plurality of power management functions.

5. The IED of Claim 4, wherein said subset of said plurality of power management functions comprises a set of register outputs stored in a memory.

6. The IED of Claim 5, wherein utilization of said set by said second power management functionality is not dependent upon a storage location of said set in said memory.

7. The IED of Claim 1, wherein said first power management functionality comprises a plurality of power management functions, said first interface being further operative to facilitate said second power management functionality to supplement a subset of said plurality of power management functions.

8. The IED of Claim 7, wherein said subset of said plurality of power management functions comprises a set of register outputs stored in a memory, said second power management functionality operative to add additional register outputs to said set.

9. The IED of Claim 1, wherein said display and communications interface is capable of being utilized by said first external function module to communicate second power management data generated by said first external function module.

10. The IED of Claim 9, wherein said second power management functionality implements a first communications protocol for use on said communication interface different from a second communications protocol implemented by said first power management functionality.

11. The IED of Claim 9, wherein said second power management data comprises parameter and setup information for said first external function module.

12. The IED of Claim 9, wherein said second power management data comprises results of computation performed by said first external function module based on said digital signal.

13. The IED of Claim 1, wherein said communications interface comprises an RS-485 serial port.

14. The IED of Claim 1, wherein said communications interface comprises an infrared port.

15. The IED of Claim 1, wherein said communications interface comprises a network port.

16. The IED of Claim 15, wherein said network comprises Ethernet.

17. The IED of Claim 1, wherein said communications interface comprises an external device control port.

18. The IED of Claim 1, wherein said interface communicates said digital signal to said first external function module.

19. The IED of Claim 18, wherein said digital signal is communicated to said first external function module continuously in real time.

20. The IED of Claim 18, wherein said second power management functionality comprises computing kilowatts based on said digital signal.

21. The IED of Claim 18, wherein said second power management functionality comprises computing harmonics based on said digital signal.

22. The IED of Claim 18, wherein said second power management functionality comprises recording a waveform of said digital signal.

23. The IED of Claim 18, wherein said second power management functionality comprises computing symmetrical components based on said digital signal.

24. The IED of Claim 18, wherein said second power management functionality comprises recording data from said first power management functionality

25. The IED of Claim 1, wherein said first interface is capable of receiving said first external function module without uninstalling said IED.

26. The IED of Claim 1, wherein said first interface is further operative to receive a plurality of said first external function modules, each of said plurality of first external function modules comprising a second interface, wherein a first of said plurality of first external function modules is coupled with said first interface and subsequent of said plurality of first external function modules are sequentially coupled with each other via said second interface and wherein said first interface communicates with each of said plurality of first external function modules as though each was connected with said first interface.

27. The IED of Claim 1, wherein said first interface is further operative to communicate with a second external function module coupled with said first external function module through said first external function module.

28. The IED of Claim 27, wherein a first connection of said second external function module to said first external function module and a second connection of said first external function module to said interface uniquely identifies each of said first and second external function modules for subsequent individual communications by said interface based on said first and second connections.

29. The IED of Claim 1, wherein said base module further comprises a first non-volatile memory operative to store first program code for execution by said processor, said processor being operative to access a second non-

volatile memory in said first external function module via said first interface, said second non-volatile memory comprising second program code, said processor further operative to replace said first program code in said first non-volatile memory with said second program code.

30. The IED of Claim 29, wherein said processor is further operative to check said second program code for compatibility with said base module prior to replacing said first program code.

31. The IED of Claim 29, wherein said processor is further operative to check a version identifier of said second program code and only replace said first program code if said version identifier identifies said second program code as a later version than said first program code.

32. The IED of Claim 29, wherein said processor is further operative to select said second program code from a plurality of program code stored in said second non-volatile memory based on compatibility with said base module.

33. The IED of Claim 29, wherein said processor is further operative to select a correct version of said second program code from a plurality of program code stored in said second non-volatile memory, each of said plurality of program code characterized by a different version.

34. The IED of Claim 29, wherein said first non-volatile memory comprises a flash memory.

35. The IED of Claim 29, wherein said second non-volatile memory comprises a flash memory.

36. An IED comprising:
a power monitoring circuit operative to monitor a parameter of a portion of a power distribution system;

a processor coupled with said power monitoring circuit and operative to receive and process said monitored parameter and generate data comprising at least one of a result of said processing and power management information;

5 a display coupled with said processor, said display comprising a plurality of visual element sets [we don't talk about visual element sets in the disclosure], each of said plurality of visual element sets comprising a plurality of visual elements, wherein a first visual element of said plurality of visual elements is capable of being activated by selecting said first visual element and selecting a corresponding of said plurality of visual element sets which includes said first visual element, said display operative to visually represent said data as a composite of a plurality of activated visual elements; and

10 wherein said processor is further operative to cyclically select each of said plurality of visual element sets and activate a subset of said plurality of visual elements in said selected visual element set corresponding to a portion of said data to be represented by said subset; and

15 further wherein said processor is operative to cycle through said plurality of visual element sets at a rate substantially fast enough to present an illusion that said data is continuously displayed on said display.

20 37. The IED of Claim 36, wherein said display comprises a matrix, wherein each of plurality of visual element sets comprises a column of said matrix and each of said plurality of visual elements form rows of said matrix.

25 38. The IED of Claim 36, wherein said display comprises a matrix, wherein each of plurality of visual element sets comprises a row of said matrix and each of said plurality of visual elements form columns of said matrix.

39. The IED of Claim 36, wherein each of said plurality of visual elements comprises a light emitting diode.

40. The IED of Claim 36, wherein each of said plurality of visual elements comprises a pixel.

41. The IED of Claim 36, wherein said processor is further operative to vary said rate to control brightness of said display.

42. The IED of Claim 36, wherein said processor is further operative to cycle through said plurality of visual element sets to display said data on said display substantially simultaneous with said processing of said monitored parameter.

43. The IED of Claim 36, further comprising a memory wherein said processor is further operative to store said data in said memory and read said data from said memory to cyclically select each of said plurality of visual element sets and activate said subset of said plurality of visual elements.

44. The IED of Claim 36, wherein said memory comprises a bit map.

45. An IED comprising:

a power monitoring circuit operative to monitor a parameter of a portion of a power distribution system;

a processor coupled with said power monitoring circuit and operative to receive and process said monitored parameter and generate data comprising at least one of a result of said processing and power management information;

a display coupled with said processor, and

wherein said processor compensates an internal temperature of the IED by adjusting an amount of power dissipated by said display.

46. The IED of Claim 45, further comprising a housing, said housing comprising said power monitoring circuit, said processor and said display, and a temperature sensor coupled with said processor, said temperature sensor operative to measure a temperature inside said housing, said processor further operative to vary a multiplexing rate to control said temperature.

47. The IED of Claim 46, wherein said processor is operative to compare said measured temperature with a threshold temperature and vary said rate to

substantially equate said measured temperature with said threshold temperature.

48. The IED of Claim 45, wherein said processor further comprises an address bus and a data bus, said display being coupled with said data and address busses wherein said processor selects each of a plurality of visual element sets using first signals transmitted on said address bus and activates a subset of a plurality of visual elements in said selected visual element set using second signals transmitted on said data bus.

49. An IED comprising :

a power monitoring circuit operative to monitor a voltage and a current of a portion of a power distribution system and generate a first analog signal representative of said voltage and a second analog signal representative of said current;

a processor coupled with said power monitoring circuit, said processor comprising an analog to digital converter operative to convert said first and second analog signals to first and second digital signals representative thereof, said processor operative to implement first power management functionality and generate first power management data;

at least one of a display and a communications interface coupled with said processor and operative to communicate said first power management data external to said IED; and

wherein said processor is operative to compensate a calibration setting of said IED to account for variations in said conversion of said first and second analog signals to said first and second digital signals due to a frequency and amplitude of said first and second analog signals.

50. The IED of claim 49 wherein said processor is operative to compensate said calibration constant for the difference in phase shift between said conversion of said first analog signal to said first digital signal and said conversion of said second analog signal to said second digital signal.

51. The IED of claim 49 wherein said compensation is accomplished by using multiple calibration points at different frequencies and amplitudes

52. The IED of claim 51 wherein said compensation is further accomplished based on fixed calibration points with a known phase relationship between said voltage and current.

53. The IED of claim 50 wherein said compensation is accomplished by using multiple calibration points at different frequencies and amplitudes.

54. The IED of claim 53 wherein said compensation is further accomplished based on fixed calibration points with a known phase relationship between voltage and current.

55. The IED of claim 49 wherein said compensation adjusts for non-linearities in the analog to digital converter within said IED.

56. The IED of claim 55 wherein said compensation is accomplished by using multiple calibration points at different amplitudes.

57. The IED of claim 56 wherein said compensation is further accomplished by using calibration points at different frequencies.

58. An IED comprising:
a power monitoring circuit operative to monitor a parameter of a portion of a power distribution system and generate an analog signal representative thereof;

an analog to digital converter coupled with said power monitoring circuit, said analog to digital converter operative to convert said analog signal to a digital signal representative thereof;

a processor coupled with said analog to digital converter and operative to implement power management functionality and generate power management data;

at least one of a display and a communications interface coupled with said processor and operative to communicate said power management data external to said IED;

an interface coupled with said processor and operative to receive a power supply; and

wherein said power supply supplies power to the IED and said power supply can be removed without uninstalling said IED.

59. The power meter of claim 58 wherein uninstalling includes removing the voltage input connections from said IED.

60. The power meter of claim 58 wherein uninstalling includes removing the current input connections from said IED.

61. The power meter of claim 58 wherein uninstalling includes removing said IED from a panel.

62. The power meter of claim 61 wherein said panel is a switchgear panel.